

U.S.C. §112, second paragraph, for being indefinite; Claims 1 and 10 were rejected under 35 U.S.C. §102(b) as being anticipated by JP 08-252305 (hereinafter "JP '305"); Claims 1-9, 11, 12 and 16 were rejected under 35 U.S.C. §102(b) as being anticipated by Murasawa et al. (U.S. Patent 5,547,823); and Claim 18 was rejected under 35 U.S.C. 101 because the claimed recitation of a use, without setting forth any steps involved in the process, results in an improper definition of a process.

In response to the objection to the specification, the noted informalities have been corrected herein. Furthermore, the specification has been revised to correct non-idiomatic languages and other informalities.

With regard to the objection and non-art rejection related to the claims, Claims 1-18 have been amended for clarification. Thus, Claims 1-18 are believed to be in compliance with the requirements of the statutes and rules noted in the Office Action. If, however, the Examiner disagrees, the Examiner is invited to telephone the undersigned who will be happy to work in a joint effort to derive mutually satisfactory claim language.

Briefly recapitulating, Claim 1 of the present invention is directed to a substrate including a fibrous material, and a photocatalytic coating material coating at least a portion of the fibrous material and including a photocatalytic semi-conducting material and an adhesion promoter for promoting adhesion to the fibrous material, the photocatalytic semi-conducting material being selected from the group consisting of an oxide semi-conducting material and a sulphide semi-conducting material, wherein the photocatalytic coating material coats fibers in the portion of the fibrous material over a thickness of between 30 and 50 nm. By providing such a photocatalytic coating material, the photocatalytic semi-conducting material can take an advantage of its mean crystallite size and thus the fibrous material is sheathed with the

photocatalytic coating material to efficiently ensure its effectiveness.¹

JP '305 discloses an air purifying sheet and its manufacturing method. Nevertheless, JP '305 does not teach "a photocatalytic coating material coating at least a portion of the fibrous material and including a photocatalytic semi-conducting material and an adhesion promoter for promoting adhesion to the fibrous material, the photocatalytic semi-conducting material being selected from the group consisting of an oxide semi-conducting material and a sulphide semi-conducting material, wherein the photocatalytic coating material coats fibers in the portion of the fibrous material over a thickness of between 30 and 50 nm," as recited in amended Claim 1. JP '305, on the other hand, discloses that the "air purifying sheet comprises polytetrafluoroethylene fine particles 13 stuck to the circumference of a glass fiber constituting glass fiber fabric 11, and a photocatalyst fine particle 14" That is, JP '305 only discloses that an aqueous dispersion containing the photocatalyst and PTEF is applied to glass fiber fabric so as to coat each fiber with the aqueous dispersion, but not over a thickness of between 30 and 50 nm. Therefore, the structure recited in amended Claim 1 is believed to be distinguishable from JP '305.

Murasawa et al. disclose a photocatalyst composite, but do not teach "a photocatalytic coating material coating at least a portion of the fibrous material and including a photocatalytic semi-conducting material and an adhesion promoter for promoting adhesion to the fibrous material, the photocatalytic semi-conducting material being selected from the group consisting of an oxide semi-conducting material and a sulphide semi-conducting material, wherein the photocatalytic coating material coats fibers in the portion of the fibrous material over a thickness of between 30 and 50 nm," as recited in amended Claim 1. Like JP

¹ Specification, page 10, lines 9-21.

'305, Murasawa et al. only disclose a photocatalyst composite in which a substrate has photocatalytic particles adhered thereon via a less degradative adhesive. Thus, the structure recited in amended Claim 1 is believed to be distinguishable from Murasawa et al.

Because neither JP '305 nor Murasawa et al. disclose the photocatalytic coating material as recited in Claim 1, even the combined teachings of these applied references are not believed to render the structure recited in Claim 1 obvious.

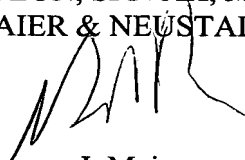
Likewise, method Claim 13 includes subject matter substantially similar to what is recited in Claim 1 to the extent discussed above. Thus, Claim 13 is also believed to be distinguishable from JP '305 and Murasawa et al.

For the foregoing reasons, Claims 1 and 13 are believed to be allowable. Furthermore, since Claims 2-12 and 14-20 ultimately depend from either Claim 1 or 13, substantially the same arguments set forth above also apply to these dependent claims. Hence, Claims 2-12 and 14-20 are believed to be allowable as well.

In view of the amendments and discussions presented above, Applicants respectfully submit that the present application is in condition for allowance, and an early action favorable to that effect is earnestly solicited.

Respectfully submitted,

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IN THE SPECIFICATION

Please replace the paragraph at page 1, lines 3-6, with the following text:

--The present invention relates to substrates provided with a photocatalytic coating, and to the process for producing such a coating and to its various applications.--

Please replace the paragraph at page 1, line 36, through page 2, line 2, with the following text:

--The aim of the invention is then the improvement of these photocatalytic coatings, being targeted in particular at improving their behaviour on any type of substrate and in particular providing them with better adhesion and better durability, [very] particularly on substrates exhibiting characteristics of surface roughness of porosity.--

Please replace the paragraph at page 3, lines 5-34, with the following text:

--A photocatalytic coating makes it possible to confer highly advantageous novel functionalities on these known substrates. Thus, the felts/mats of mineral wool mainly used in insulation can be treated only superficially, only on one of their faces, for example, or on each of their faces, and can acquire a dirt-repellent/odour-controlling function on at least one of their treated faces (the visible face and /or the hidden face) in false ceiling structures of buildings, in antinoise screens alongside roads or railways, and the like, the condition laid down being that the photocatalytic coating is accessible to a natural or artificial light source.

Still in the field of insulation, the [abovementioned] "moulds" can also be treated on the inside and/or outside or over their entire thickness, for example, in order to confer on them a dirt-repellent and/or bactericidal or fungicidal function. In the form of mats or of moulds, the substrates treated according to the invention can advantageously be positioned around outlet conduits in any ventilation or air-conditioning system but also by being positioned inside these conduits, these devices being veritable breeding grounds for bacteria, the condition being that it is necessary to provide means for the photocatalytic coating to be exposed to sufficient ultraviolet radiation to be effective: on a visible external face, natural illumination may be sufficient. If not, the substrates have to be combined with artificial illuminating means of the halogen lamp or fluorescent tube type.--

Please replace the paragraph at page 4, lines 12-20, with the following text:

--The term [of] "filter" covers two notions within the meaning of the invention, both the notion of true filtration, where particles are separated mechanically from the gas carrying them, and the notion of diffuser, in particular of odour-controlling diffuser, where the gas to be treated is not necessarily forced to pass through the photocatalytic substrate, where it can in particular simply be brought into contact with the latter, without retaining the suspended particles.--

Please replace the paragraph at page 4, lines 30-39, with the following text:

--The filters, surface-treated or treated throughout their thickness, can become much more effective and much more durable; this is because the treatment according to the invention gives them the ability not only to remove microorganisms but also to decompose organic residues of fatty type [which generally constitute a good part of the] , for example,

particles which gradually block the filter. With the invention, these filters therefore have a longer lifetime. In addition, they have [a] an odour-controlling function.--

Please replace the paragraph at page 5, lines 10-17, with the following text:

--The advantage of treating [according to the invention] all these fibrous substrates according to the present invention has been seen. However, to furnish term with a photocatalytic coating was not, initially, very easy. This was because the question arose of the method of deposition of the coating on a substrate which is generally non-smooth, non-flat and of rough and porous type, as well as the question of the durability of this coating.--

Please replace three paragraphs at page 5, line 29, through page 6, line 16, with the following text:

--According to a first [alternative form] embodiment of the present invention, the titanium oxide is already at least partially precrystallized in anatase form when it is incorporated in the coating, before being deposited on the substrate. It can be introduced into the coating in the form of crystalline particles in colloidal suspension or in the form of a dry power composed of particles which are optionally more or less agglomerated with one another. This alternative form exhibits the advantage of not imposing a high specific heat treatment on the coating/substrate on which it is deposited (TiO_2 crystallizes in the anatase form generally in the vicinity of 400°C).

According to a second [alternative form (] embodiment of the present invention which can be combined with the first[)] embodiment, the titanium oxide originates from the thermal decomposition of precursors, in particular of the organometallic or metal halide type, within the coating. The anatase crystallized TiO_2 can thus be manufactured "in situ" in the coating,

once applied to the substrate, by providing for an ad hoc heat treatment, which must, however, be compatible with the chosen substrate and the chosen adhesion promoter.

[As regards the] The adhesion promoter[, the latter] can be single- or multicomponent, and [it being possible for] its component or components [to be] can be organic, inorganic or organic/inorganic "hybrids".--

Please replace two paragraphs at page 6, line 26, through page 7, line 15, with the following text:

--The adhesion promoter can also comprise one or more polymers of organic type. In fact, two scenarios exist: standard organic polymers, for example of the acrylic or phenol-formaldehyde type, or the like, can be chose. In this case, there is a risk of this component being gradually decomposed by photocatalysis by the TiO_2 , at least in the [(surface)] surface regions of the substrate liable to be exposed to ultraviolet radiation. However, the process can in fact prove to be advantageous in some applications, by thus gradually "releasing" active TiO_2 . However, it may be preferable to avoid or slow down as far as possible this decomposition by choosing appropriate polymers, generally fluorinated polymers, which are highly resistant to photocatalytic attacks, for example of the fluorinatd acrylic polymer type, of the polytetrafluoroethylene (PTFE), poly (vinylidene fluoride) (PVDF) or tetrafluoroethylene-ethylene copolymer (ETFE) type, and the like.

One alternative [consists in] is retaining an adhesion promoter based on organic polymer(s) and [in] thwarting their decomposition by appropriate additives, in particular belonging to the family of the antioxidants (such as the product sold under the name Irganox by the company Ciba) and /or of the ultraviolet absorbers (such as the product sold under the name Tinuvin by the same company) and/or of stabilizers in the form of sterically hindered

amines known under the term "hindered amine light stabilizers" or "HALS".--

Please replace the paragraph at page 10, line 25, through page 11, line 19, with the following text:

--According to a first alternative form, the photocatalytic coating is deposited, in the liquid phase, on the production line itself for the fibrous material. The advantage to this alternative form lies in the fact that the still semi-finished fibrous material can be treated and the best use can be made of the temperature which it is at, for example, resulting in a saving in terms of time and of production cost. This, a first embodiment consists in "hot" depositing the coating between the fiberizing devices and the devices for receiving the fibres. The fiberizing devices can consist of glass centrifuging dishes, known as "internal centrifuging devices", such as [are] ones disclosed, for example, in Patents EP-0,189,534 and EP-0,519,797, making it possible to fiberize mineral wool of glass type, or devices for fiberizing by so-called external centrifuging using a succession of centrifuging wheels, such as [are] ones disclosed, for example, in Patents EP-0,465,310 or EP-0,439,385, making it possible to obtain mineral wool of basalt rock type. It can also relate to devices for fiberizing by mechanical drawing, in order to obtain reinforcing glass strands, by air blowing or by steam blowing, according to processes well known to persons skilled in the art. Use is thus made of the fact that the fibres are still at a relatively high temperature by applying the coating, generally in solution/dispersion, in a solvent, for example an aqueous solvent, which evaporates on contact with or in the vicinity of the fibres. The heat can also make it possible to cure the component or components of the adhesion promoter, if they are of the resin type, or to decompose them thermally, if they are of the silicon-comprising precursor or metallic precursor type mentioned above.--

Please replace the paragraph at page 12, lines 6-18, with the following text:

--As mentioned above, it is therefore possible to deposit the photocatalytic coating just under the bushing, in particular concomitantly with the deposition of the size, in which [is] it can be incorporated. It is also possible to deposit it during the stage of finishing the spooled strands into finished products: it can, for example, relate to the conversion operation targeted at manufacturing mats of chopped strands, in a subsequent operation; it is also possible to deposit it on the downstream line, in particular during the conversion of the continuous strands, gathered together as a blanket, into a mat of continuous strands.--

Please replace three paragraphs at page 13, lines 18-39, with the following text:

--Another subject-matter of the invention [is] relates to the application of these treated substrates to thermal/sound insulation or facing materials, with a dirt-repellent, fungicidal, antibacterial or odour-controlling function, or to liquid or gas filters of paper type or of felt or mould type.

Other advantageous details and characteristics of the invention [emerge from the description below of] become apparent from the non-limiting [implementational examples] embodiments described below in reference to [using] the following [figure] figures:

Figure 1 shows [□ Figure 1:] [negative obtained by] a scanning electron microscopy (SEM) photograph of the surface of a fibrous material treated according to an embodiment of the invention[.];

Figure 2 is another SEM photograph showing the surface of the fibrous material shown in Figure 1; and

Figure 3 is yet another SEM photograph showing the surface of the fibrous material shown in Figure 1.

All the following examples relate to the deposition of a coating for which the photocatalytic "active" components are made of anatase crystallized TiO_2 . [(It goes without saying that, as] As mentioned above, the invention applies in the same way to semi-conducting "active" components with photocatalytic properties similar to anatase TiO_2 and which can be provided in the same form, in particular zinc oxide, tin oxide and tungsten oxide[)].--

Please replace four paragraphs at page 14, line 8, through page 15, line 22, with the following text:

--This solution [comprises a dispersion of] containing particles of TiO_2 crystallized in anatase form, probably composed of crystallite agglomerates, these agglomerates having a mean size of the order of 20 to 80 nm. These particles are therefore the "active" components in terms of photocatalysis. The solution also [comprises] contains an organometallic TiO_2 precursor which will decompose into predominantly amorphous TiO_2 by heat treatment and which will act as adhesion promoter.

The coating obtained was baked at 200°C for 2 hours and [comprises] contains anatase nanocrystals in an amorphous TiO_2 matrix. The yellow colour of the filter thus manufactured testifies to the presence of organic compounds originating from the precursor solution. After exposure to ultraviolet A radiation under a dose of 4 W/m^2 for 2 hours, the yellow colour has completely disappeared, which shows complete decomposition of the residual organic pollutants.

EXAMPLE 2

Glass fibre of insulation type obtained by binder-free internal centrifuging was converted by the papermaking route in pure water. The paper obtained, circular with a

diameter of 100 mm and a weight per unit area of 150 g/m², was subsequently impregnated over its entire thickness by dip-coating it in an alcoholic dispersion [comprising] containing, by volume, 5% water, 1% tetraethoxysilane (the adhesion promoter) and 1% anatase crystallized TiO₂ particles with a mean diameter of 30 nm (the "active" components). The paper was dried in the open air and then baked in an oven at 450°C for 30 minutes. This filter was subsequently placed over an inlet orifice of a fume cupboard. A control filter, without anatase TiO₂, was placed over the neighbouring orifice. An ultraviolet A lamp shines on these filters at a dose of 4 W/m². After the cupboard had been operated for 15 days, the treated filter was still white, whereas the untreated filter was fouled.

EXAMPLE 3

A composition for the sizing of glass wool of insulation type obtained by internal centrifuging was manufactured by mixing:

- [⇒] 55 G of resin obtained by condensation of phenol and formaldehyde in an initial formaldehyde/phenol molar ratio of approximately 3.2/1, which condensation is carried out conventionally with a catalyst in the form of sodium hydroxide at 5.5% by weight with respect to the phenol,
- [⇒] 45 g of [...rea] urea,
- [⇒] 3 g of aminopropyltrimethoxysilane,
- [⇒] 0.3 g of ammonium sulphate,
- [⇒] 6 g of 30% by volume aqueous ammonia,
- [⇒] 1200 g of a 25% by weight dispersion in water of anatase crystallized TiO₂ particles,
and
- [⇒] 34 litres of water.--

Please replace the paragraph at page 17, lines 11-17, with the following text:

--[Finally,] Examples 3 and 4 illustrate an in-line hot deposition under the fiberizing devices, which will make possible treatment within the thickness of the fibrous material, with "precrySTALLIZED" TiO_2 particles and adhesion promoters of the family of the silanes in combination with the components of a standard size, in the aqueous phase.--

Please change the page numbers after page 17 to subsequent consecutive numbers starting with 18.

Please replace the paragraph at page 18, lines 16-19, with the following text:

--An 80 g/m^2 glass web was impregnated with an aqueous solution [comprising] containing 3.1% of Glymo (glycidoxypopyltrimethoxysilane) and 2.9% of titanium dioxide nanoparticles at a rate of 0.2 m/min.--

Please replace the paragraph at page 19, lines 16-20, with the following text:

--According to the same process, a 60 g/m^2 glass web was impregnated in an aqueous solution [comprising] containing 1 g/l of A1100 silane and 5 g/l of titanium dioxide (sold under the name P25 by Degussa) held in suspension by appropriate means.--

Please replace the paragraph at page 19, lines 27-37, with the following text:

--A circular specimen of web (diameter 100 mm) was placed at mid-height in a 300 ml beaker. The bottom and the edges of the receptacle having been rendered opaque, the beaker is illuminated by a bank of UV-A lamps (365 nm) delivering a power of 3.5 mW/cm^2 to the web. An aqueous solution (deionized water) [comprising] containing 10 mg/l of

phenol is poured into the device and is kept stirred magnetically. The decrease in concentration of the phenol is then monitored, samples being withdrawn at regular time intervals, by a UV spectrometer sold by Dr Lange.--

IN THE CLAIMS

Please amend Claims 1-18 and add new Claims 19-20 as follows:

--1. (Amended) A substrate [Substrate] comprising:

a fibrous material; and [which is provided, over at least a portion of its surface and/or within its thickness, with]

a photocatalytic coating [with photocatalytic properties comprising] material coating at least a portion of the fibrous material and including a photocatalytic semi-conducting material [with photocatalytic properties] and an adhesion promoter for promoting adhesion to the fibrous material, the photocatalytic semi-conducting material being selected from the group consisting of [the] an oxide semi-conducting material [or] and a sulphide semi-conducting material, [type, in particular titanium oxide at least partially crystallized in anatase form, the said material being used in combination with a promoter of adhesion to the said fibrous material]

wherein the photocatalytic coating material coats fibers in the portion of the fibrous material over a thickness of between 30 and 50 nm.

2. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein:

the photocatalytic semi-conducting material [of the] comprises titanium oxide which is at least partly crystalized in anatase form; and

the titanium oxide is in a form of [type is introduced into the coating in the form] one of particles in colloidal suspension [or in the form of] and a powder.

3. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the [titanium oxide originates] photocatalytic semi-conducting material comprises a titanium oxide from [the] one of thermal decomposition of organometallic [or] and at least one metal halide [precursor(s)] precursor [within the coating].

4. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter [is] comprises at least one of an organic material, an inorganic material, and an [or] organic/inorganic hybrid[, single or multicomponent] material.

5. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter comprises a silicon-comprising component selected from the group consisting of [the] silane, silicone [or] and siloxane [type].

6. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter comprises at least one organic polymer selected from the group consisting of [one or more organic polymers, in particular] acrylic polymers[, or] and fluorinated polymers[, optionally in combination with additives belonging to the family of the antioxidants and/or of the ultraviolet absorbers and/or of the stabilizers of the "HALS" type].

7. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter comprises at least one [metal] oxide selected from the group consisting of [the] TiO_2 [or] and SiO_2 [type originating] from [the] one of thermal decomposition of silicon-comprising, organometallic or metal halide precursor(s) within the photocatalytic coating material.

8. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter comprises at least one inorganic component [chosen] selected

from the group consisting of aluminium phosphates, [and] potassium [or] aluminosilicates and calcium aluminosilicates.

9. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the adhesion promoter forms part of [the] a binder [making possible the] providing cohesion of the fibrous material[, in particular of the sizing type for mineral wool or sizing type for reinforcing strands or binder type for a mat obtained from reinforcing strands].

10. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the [mineral] fibrous material comprises at least one of insulation mineral wool [of the insulation type and/or] and reinforcing glass strands [of the reinforcing type].

11. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the fibrous material is [organized in the] one of web, felt, mould, paper [or] and bulk material [form] forms.

12. (Amended) The substrate [Substrate] according to Claim 1, [characterized in that] wherein the photocatalytic coating [with photocatalytic properties sheaths] material coats the fibers in the portion of [at least a portion of the fibres of] the fibrous material over a thickness of at least 5 nm[, in particular of between 30 and 50 nm].

13. (Amended) A process [Process] for [the manufacture of the] manufacturing a substrate, [according to Claim 1, characterized in that] comprising:

depositing a liquid binder to bind fibers and form a fibrous material; and

depositing a [the] photocatalytic coating material [with photocatalytic properties is deposited] in [the] liquid phase [on the production line for the] over at least a portion of the fibrous material such that the photocatalytic coating material coats fibers in the portion of the fibrous material over a thickness of between 30 and 50 nm, the photocatalytic material including a photocatalytic semi-conducting material and an adhesion promoter for promoting

adhesion to the fibrous material, the photocatalytic semi-conducting material being selected from the group consisting of an oxide semi-conducting material and a sulphide semi-conducting material [, in particular between the fiberizing devices, of the centrifuging dish, device for fiberizing by external centrifuging, device for fiberizing by mechanical drawing, device for fiberizing by air blowing or device for fiberizing by steam blowing type, and the devices for receiving the fibres, optionally before, with or after the deposition of the binder in the liquid phase of the fibres to one another, of the sizing composition type].

14. (Amended) The process [Process for the manufacture of the substrate] according to Claim [1] 13, [characterized in that] wherein the depositing the photocatalytic coating [with photocatalytic properties is deposited in the liquid phase on the production line for the fibrous] material comprises depositing the photocatalytic coating material downstream of [the devices for receiving the fibres resulting from the] a fiberizing [devices, in particular] device before [the optional] heat treatment/conditioning devices [of the stove type].

15. (Amended) The process [Process for the manufacture of the substrate] according to Claim [1] 13, [characterized in that] wherein the depositing the photocatalytic coating [with photocatalytic properties is deposited in the liquid phase on the production line or outside the production line for the fibrous] material comprises depositing the photocatalytic material during [the operation of] a conversion operation of the [latter] fibrous material into [the finished product, in particular during the operation of conversion of blankets of reinforcing strands into] mats.

16. (Amended) The process [Process for the manufacture of the substrate] according to Claim [1] 13, [characterized in that] wherein the depositing the photocatalytic coating [with photocatalytic properties is deposited in the liquid phase on the finished fibrous] material [and then] comprising depositing the photocatalytic coating material after converting

the [said] fibrous material into a finished product and before [is subjected] subjecting the finished product to a heat treatment.

17. (Amended) The process [Process] according to Claim 13, [characterized in that] wherein the depositing the photocatalytic coating [is deposited in the fluid phase, in particular the liquid phase, by] material comprises one of spraying, coating [or] and dip coating.

18. (Amended) The [Application of the] substrate according to Claim 1, wherein the fibrous material comprises one of a thermal insulation material, a sound insulation material, a liquid filter, a gas filter, a purifier, and a diffuser [to thermal/sound insulation materials or to liquid or gas filters, purifiers or diffusers, in order to confer on them dirt-repellent, fungicidal, bactericidal, algicidal or odour-controlling properties].

19.-20. (New)--